Summary of the Muggah Creek Phase II Environmental Site Assessment

SUMMARY OF MAJOR FINDINGS

Major findings of the Phase II Environmental Site Assessment (ESA) are summarized on this page, and include:

- Fill material within the Investigation Area was identified as the main geologic unit containing soil contamination. The Coke Ovens and MAID Sites had the most extensive areas of fill materials.

- Elevated contaminant concentrations were found in surface soils throughout the Area North of the Coke Ovens Site and require further work to assess the potential impacts to residents.

- Coke Oven Brook is the major route by which contaminants are moved from both the MAID and Coke Ovens Sites. Inorganic contaminant impacts (e.g., metals) on Coke Oven Brook were especially evident downgradient of the MAID Site, while organic contaminant impacts (e.g., PAHs) were evident below the Coke Ovens Site.

- Within Coke Oven Brook, evidence of free product (i.e., coal tar) was noted both along Domtar Brook and in Coke Oven Brook. from the Benzol Plant at least to Victoria Road Overpass. Product was also noted further downgradient, within the Coke Oven Brook Connector study site.

- Within the Investigation Area, groundwater migrates in an east to west direction, from the MAID Site towards South Pond. Groundwater discharge to Coke Oven Brook was identified as a critical control on both groundwater flow and contaminant migration, particularly from the MAID and Coke Ovens Sites.

- Groundwater contaminated by the MAID Site migrates westward within the shallow bedrock onto the eastern Coke Ovens Site, however the degree of groundwater impact decreases westward. Contaminated groundwater beneath the MAID Site extends at least to a depth of 35 m within bedrock and westward migration of this deeper impacted groundwater is expected.

- Soil and groundwater impacts were found on the Coke Ovens Site, and those sites most impacted included: the Domtar Site, the Coal Pile Runway, the Benzol Plant and Tanks, the Coke Storage Area and the By-Products Building. At these sites, impacts were greatest in the area of former and/or existing infrastructure, whose presence generally promotes lateral and vertical migration of contaminants within the Coke Ovens Site.

- Fewer contaminant impacts were noted at other areas within the Coke Ovens Site, and these impacts were usually either localized and/or confined to a single media (e.g., surface soil, groundwater).

- Thick coal tar saturated fills were found throughout the Domtar site, and widespread contamination was noted in both site soils and groundwater. Liquid coal tar in groundwater was found at several locations within the Domtar fill and bedrock units, but its vertical extent was not determined. Contamination present within the Domtar Site continues to act as an on-going source of impacts long after site operations ceased.

- Most contaminated groundwater from the Coke Ovens Site moves westward, under the eastern portion of the Coke Oven Brook Connector and out under the Sysco Plant, towards South Pond.

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WHAT WAS INVOLVED IN THIS ENVIRONMENTAL SITE ASSESSMENT?

As recommended by the Joint Action Group (JAG), a detailed study was undertaken in 2000-2001 on behalf of federal, provincial and municipal governments to acquire more specific information on environmental impacts on the Investigation Area within the Muggah Creek Watershed.

This information was intended to define the nature of environmental impacts within the Investigation Area, and the relationship of these impacts between adjacent sites within the Muggah Creek Watershed.

This study i. called the "Phase II Environmental Site Assessment Report" and was conducted as part of the Phase II/III Environmental Site Assessment for the Muggah Creek Watershed.

The Canadian Council of Ministers of Environment (CCME) has developed a step-by-step process to assess contamination, plan and implement remediation, and monitor remediation of contaminated sites. The ESA portion covers three of the phases and requires a series of investigations to answer questions regarding the condition of the site, such as:

- historical information review, to assess if potential exists for site contamination based on past activities (Phase I)
- if potential exists, assess what contaminants are likely to be present (Phase II - site intrusive work)
- further define nature and extent of contamination present (Phase III - detailed site intrusive and risk work)
- planning/remediation design, if contaminants are present (Phase IV)
- remediation of contaminants where present is undertaken in Phase V, while
- monitoring of remediation efforts is included within Phase VI

Each phase of the ESA involves more complex investigations (i.e., digging, drilling, more sampling) but also yields significantly more detailed data. Ultimately, this provides a better basis for remediation decisions. Prior to the Phase II ESA, a limited amount of data had been gathered in a few areas but this data did not look at impacts between sites (e.g., data available for Coke Oven Brook, but none on impacts of Coke Ovens Site on the brook). Prior to the Phase II Report, there were critical knowledge gaps, particularly with respect to the type of contaminants present, whether they existed in site surface soils, subsurface soils and/or groundwater. In addition, site contaminant impacts on surface waters, especially Coke Oven Brook, and/or their role in transporting contaminants was poorly understood.

OBJECTIVES OF THE STUDY

The objective of the Phase II assessment is to provide environmental information that is complete and sufficiently detailed so it can be used to evaluate appropriate remedial options. Those options would be considered by government based on advice from technical experts and recommendations from the Joint Action Group and would aim to:

- prevent human contact with contaminants
- prevent spread of contaminants
- identify and address historic and ongoing sources of contamination

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WHEN WAS THE WORK DONE?

The Phase II field program began in early July 2000 and was completed in late November 2000. Following lab analysis of samples, these results were interpreted and reported in 2001.

WHAT AREAS WERE TESTED?

Figure 1 shows the general study area for the Phase II ESA. The study area was divided into five regions:

- Area North of the Coke Ovens (NOCO)
- Municipal Ash Incinerator Disposal (MAID) Site
- Coke Oven Brook Connector
- Coke Ovens Site
- Surface Waterways

COMPARING THE RESULTS TO STANDARDS AND GUIDELINES

Once samples were analyzed, results were compared with appropriate soil and water quality guidelines and /or background values. Surface soils were only compared to CCME criteria. Subsurface soils were compared to both CCME and background criteria. CCME Drinking Water and background criteria were used for groundwater, while CCME Freshwater Aquatic Life (FAL) and background criteria were used for surface water. Except for NOCO where CCME Residential criteria were used, Commercial/Industrial CCME criteria were used for soils. No CCME criteria are available for total petroleum hydrocarbons (TPH), therefore provincial Partners in RBCA Implementation (PIRI) values were used. No CCME or PIRI criteria exist for HNCs. Only exceedences relative to CCME/PIRI criteria are presented in this document. For simplicity reference will be made only to CCME criteria and it is implicitly understood that for TPH values, PIRI criteria are used. When the lab detection limit was above CCME criteria, any CCME exceedences were considered "unconfirmed" and are not discussed in this document.

CCME criteria are intended to be used as "general guidance only" and to evaluate whether additional site investigation work is necessary based on concentration/type of chemical present and a particular land use. They are not designed or intended to replace site-specific risk based criteria.

WHAT WE FOUND: STUDY RESULTS

The Phase II ESA results provided the first integrated assessment of the Muggah Creek Watershed Investigation Area. These results are summarized in the following sections, organized as follows: NOCO, MAID Site, Coke Oven Brook Connector, Coke Ovens Site and Surface Waterways. Figure 2 presents three geologic cross-sections through the study area, while Figure 3 presents groundwater flow directions in shallow bedrock. Two Phase II summary tables are included: Table 1 - work completed, and Table 2 - the analytical program. A list of abbreviations and units used in this document is provided in Table 3.

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NOCO AREA

Background: The NOCO Area is about 43 hectares, and is bounded on the north and west by homes and some commercial properties of Whitney Pier, and to the south by the Coke Ovens Site. Three investigations in 1997 and 1998 have been undertaken within the NOCO Site, generally along and/or south of Frederick Street. Evidence of landfill impacts were identified by the 1997 study in the eastern most portion of Upper Frederick Street. Elevated metals and PAHs in soils, groundwater and stream sediments were noted in the 1998 Lower Frederick Street study. The Coke Ovens Site, MAID Site, fill materials along Frederick Street, Cape Breton Development Corporation (CBDC) railway and air borne particles associated with adjacent operations (e.g., Coke Ovens, Sysco) were considered potential sources of contamination for this site. Phase II work is summarized in Tables 1and 2. Phase II work was divided into four areas: Upper, Middle and Lower Frederick Street, and west of Lingan Road. In November 2001, Health Canada completed an extensive sampling and risk assessment program within the NOCO Site, initiated by Phase II ESA results.

Results: Phase II results confirm impacts to both soils and groundwater. Surface soil metals (arsenic, copper, lead, thallium), petroleum hydrocarbons (BTX, TPH) and many PAHs were found to exceed CCME criteria in most areas, but particularly Lower Frederick Street and West of Lingan Road. Mercury and cyanide did not exceed CCME criteria. No PCBs, no dioxins/furans above CCME criteria, typically no HNC and non-PAH EPA625 compounds were detected. Elevated metals, hydrocarbons and possibly PAHs, may be associated with coal or coal wastes often found in surface soils, that may originate from imported fill materials, the Coke Ovens Site, and/or home heating use. Subsurface soil metals (arsenic), petroleum hydrocarbons (TPH), and several PAHs were frequently found to exceed CCME criteria, usually in Lower Frederick St. and West of Lingan Road. Exceedences were often associated with fill materials. No PCBs, no dioxins/furans above CCME criteria, and typically no non-PAH EPA 625 compounds were detected. Carbazole was the only HNC detected. Groundwater inorganic (turbidity, color) and metals (iron, manganese) exceeded CCME criteria in all NOCO wells. However, their presence may not indicate contamination but reflect natural conditions; criteria for these parameters were established for aesthetic, not health reasons. Isolated exceedences of other metals (arsenic, sulfate) and gross alpha/beta were also noted. No cyanide or mercury was detected. Petroleum hydrocarbons were typically not detected. Many PAHs at low concentrations were detected in most wells, but only benzo(a)pyrene exceeded CCME criteria. No PCBs, no EPA624 (volatile) organics, no dioxins/furans above CCME criteria, and typically no non-PAH EPA625 compounds were detected. Carbazole was the only HNC detected. Impacts east of Upper Frederick Street may be due to the MAID Site, while impacts to a few wells in Lower and Middle Frederick Street and West of Lingan Road were likely associated with presence of fill and/or migration of Coke Ovens Site contaminants. It was recommended that impacts of Phase II data on human health be assessed, surface soil sampling in NOCO and adjacent areas be undertaken, soil/groundwater sampling be undertaken to further assess identified impacts (e.g., Upper Frederick St., between Coal Pile Runway and Frederick St., West of Lingan Road), extent of fill be determined south of Frederick St. and Currys Lane, geophysical anomalies be assessed, and more groundwater quality data be collected.

MAID SITE

Background: The MAID Site is about 90 hectares, and lies east and upgradient of the Coke Ovens Site. It consists of three disposal areas: Marsh Dump, Sydney Landfill and Incinerator Landfill. Waste disposal from the Coke Ovens and Steel Plant began in the early 1900s; municipal waste disposal started after 1950. In the late 1980's, disposal of ash and other wastes from the Cape Breton County Incinerator started. Previous work has been undertaken at various site areas in 1985, 1988, 1991 and 1999. These investigations indicated the presence of bedrock groundwaters and surface waters that were impacted by metals and PAHs. For Phase II work the site was divided into four areas: North Perimeter, Central Area, Sydney Landfill and West Perimeter. Phase II work is summarized in Tables 1 and 2.

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Results: Phase II results confirm impacts to both soils and groundwater. Widespread evidence of contaminants were noted in surface and subsurface soil, and groundwater throughout areas used for waste disposal. No impacts were found north of the CBDC railway. Surface soil metals and PAHs were frequently found above CCME criteria, as expected in a landfill area; petroleum hydrocarbons typically met applicable criteria. Subsurface soil metals often exceeded CCME criteria, as expected for landfilled materials. Relatively few petroleum hydrocarbons and PAHs exceeded CCME criteria. No PCBs were detected in the till samples collected. Groundwater inorganic (e.g., ammonia, hardness, TDS) and metal (e.g., sulfate, iron, manganese) impacts were noted and considered associated with MAID Site leachate. Impacts were generally noted within shallow and intermediate groundwaters in the western Central Area, Sydney Landfill and West Perimeter. Vertical leachate impacts on bedrock groundwater extend at least to a depth of 35 metres in the West Perimeter. Impacted shallow bedrock groundwater migrates westward onto the Coke Ovens Site. Impacted groundwater within deep bedrock is also expected to migrate westward; no deep wells were available on the eastern Coke Ovens Site to assess depth of impact. Sydney Landfill groundwater was most impacted by MAID Site leachate. Discharge of leachate impacted overburden and bedrock groundwater into Coke Oven Brook, from the west Central Area and Sydney Landfill, is expected and represents a significant contaminant transport pathway. Phase II work indicates presence of thin (i.e., less then 0.3 m) to non-existent till within portions of the MAID Site, and vertical migration of leachate impacted groundwater from the waste fill into underlying bedrock is expected. Groundwater within bedrock under the Central Area, migrates westward beneath the Sydney Landfill, where it helps maintain groundwater levels within waste fills and results in further leachate generation. Impacts from Sydney Landfill leachate were noted within central and northern portions of the West Perimeter. Leachate impacted groundwater was detected north of Coke Oven Brook, and may be associated with migration of impacted groundwater or leachate impacted surface waters. Few organic contaminants were detected in MAID Site groundwater; no patterns of organic contaminant distribution were evident. Typically the highest concentration of organic parameters were found within the Sydney Landfill. Concentrations of organics (e.g., PAHs, petroleum hydrocarbons) appeared to be confined to individual wells, rather than forming broad areas of particular organic contamination. It was recommended that monitoring to assess groundwater-surface water interaction within portions of Coke Oven Brook adjacent to the MAID Site be incorporated into the Surface Waterways Monitoring Program, more groundwater quality data be collected, MAID Site leachate impacts within the eastern Coke Ovens Site be characterized, and additional groundwater modeling assess effects of landfill capping on both impacted groundwater flow beneath the MAID Site and downgradient migration.

COKE OVEN BROOK CONNECTOR

Background: The strip of land along Coke Oven Brook between the Victoria Road Overpass and South Pond is called the Coke Oven Brook Connector and is about 3 hectares in area. This portion of Coke Oven Brook is considered a major historical pathway for contaminants discharged from upgradient industrial and municipal sources (e.g., Coke Ovens, MAID Site, Whitney Pier sewerage). Although some surface water monitoring has been conducted in this portion of Coke Oven Brook, it has not been previously subject to intrusive investigation. Historic maps indicate that in 1902 Muggah Creek estuary extended almost to Victoria Road Overpass. Infilling associated with past Sysco operations has been responsible for the present configuration of Coke Oven Brook in this area. Previous work in 1985 identified PAH contaminated estuarine sediments in areas adjacent to this section of Coke Oven Brook. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soils and groundwater. Surface soil metals (arsenic, copper, lead, thallium) and PAHs (benzo(a)pyrene) exceed CCME criteria. Petroleum hydrocarbons were detected but were not elevated above applicable criteria. No PCBs and typically no non-PAH EPA 625 compounds were detected. Carbazole was the only HNC detected. Subsurface soil metals (arsenic, lead), petroleum hydrocarbons (BTX, TPH) and PAHs (benzo(a)pyrene) frequently exceeded CCME criteria. Most contaminants were associated with fills that originated from impacted estuarine sediments or Sysco infilling. Groundwater inorganic (color, turbidity, TDS) and metals (sulfate, iron, manganese) and PAHs (benzo(a)pyrene) typically exceeded CCME criteria in fill, shallow and intermediate bedrock wells. Less frequently other metals (sodium, selenium) and petroleum hydrocarbons exceeded

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CCME values. EPA 624 results also detected volatile petroleum hydrocarbon constituents (BTE) above CCME criteria. No PCBs and typically no non-PAH EPA 625 compounds were detected. Carbazole was the only HNC detected. Presence of DNAPL was noted in a shallow Canso bedrock well, and was reflected in number/concentration of organics detected (e.g., BTEX, naphthalene, HNCs). Whether the DNAPL migrated vertically downward from overlying fills or laterally in the bedrock, was not determined. Site contaminated groundwater may be associated with contaminated fill materials, interaction with Coke Oven Brook, and/or groundwater migration from the Coke Ovens Site. Chloride, sulfate and TDS indicators suggest a major shallow bedrock groundwater contaminant pathway from the Coke Ovens Site, passes through the eastern Coke Oven Brook Connector. It was recommended that groundwater monitoring wells be installed and incorporated into the Surface Waterways Monitoring Program, and shallow bedrock wells installed to assess westward migration of contaminants from the Coke Ovens Site.

COKE OVENS SITE

Domtar Site

Background: The Domtar facility occupies about 6 hectares in the northwest corner of the Coke Ovens Site. Operated by Domtar from 1903-63, it contained primary and secondary tar lagoons, an above grade tank farm with 17 tanks, oil/tar distilling units, an administration building and load-out platform with rail sidings. Historic data suggests products were refined from on-site tar and/or creosote manufacturing operations. The primary tar lagoon located in the northwest corner of the site, was apparently used for temporary tar storage when the tank farm capacity was exceeded. Apparently constructed above grade with fill embankments, this lagoon had a maximum berm height of about 3 metres. Its west perimeter was adjacent to the former Victoria Road Subway which was probably excavated into bedrock. A secondary lagoon was located east of the primary lagoon. The plant closed in 1963 but coal tar remained in both lagoons until 1981 when most was removed; some was left and apparently mixed with the slag fill used to backfill the lagoons. In 1988-89, 16 tanks were removed. The largest, an open steel 500,000 litre tank, remains on-site; various tars, chemicals and waste materials have been dumped into this tank since 1963. Periodically this tank overflows with rainwater and discharges to ground surface. In the past 12 years, numerous tar seeps within the former tank farm, along the toe of the southern primary lagoon berm and within the bed of Domtar Brook have been noted. Very limited work in 1985, more detailed intrusive work in 1990, limited additional sampling work in 1997 and geophysical work in 1999 has been completed on-site. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soils and groundwater. Surface soil metals (arsenic, thallium) and many PAHs frequently exceeded CCME criteria. Petroleum hydrocarbons, though detected, usually did not exceed criteria. One EPA 624 parameter (toluene) exceeded CCME criteria. No PCBs and typically no non-PAH EPA 625 compounds were detected. HNCs (carbazole, acridine) were detected in most samples. Dioxins/furans below residential CCME criteria (no commercial/industrial criteria) were found. Subsurface soil metal (arsenic), petroleum hydrocarbons (toluene, xylene), many PAHs exceeded CCME criteria. Naphthalene and phenanthrene (PAHs) usually had the highest concentrations. Phenol was the only non-PAH EPA 625 organic above CCME criteria; PAH interference caused elevated detection limits for most parameters. HNCs were also detected in all samples. No PCBs were detected. Most fill samples exceeded CCME criteria and had higher contaminant concentrations, while till samples had fewer exceedences and lower concentrations. DNAPL was often noted in fills under the former Tank Farm and downgradient of the primary lagoon, both are DNAPL source areas. Groundwater inorganic (color, turbidity), metal (iron, manganese), petroleum hydrocarbons (BTEX) and PAHs (benzo(a)pyrene) usually exceeded CCME criteria. BTEX compounds and PAHs, particularly naphthalene, were considered to be the major site groundwater contaminants. HNCs were frequently detected. No PCBs were detected. Dioxins/furans below residential CCME criteria (no commercial/industrial criteria) were found. Presence of DNAPL in both shallow Morien and Canso bedrock, and along the fill/till interface was reported in 1988; Phase II work noted DNAPL the 1988 wells, plus two new wells. Results indicate that DNAPL migration from the fill into bedrock, occurs both directly through the till, and via localized areas where no till exists; other migration pathways include subsurface infrastructure and the

former Victoria Road Subway. Ongoing migration of contaminants from the site was noted, with comparison of Phase II and historic data. In the shallow bedrock, contaminants migrate off-site to the west-southwest onto the Sysco property and the Coke Oven Brook Connector. In the fill, contaminants migrate into Domtar Brook over much of the site, as well as westward onto Sysco and Coke Oven Brook Connector properties, and possibly beneath the Victoria Road Overpass. It was recommended that surface soils and fills be characterized further, site groundwaters be better assessed (i.e., impact of fill groundwater contamination, vertical extent of impacts, interaction with Coke Oven Brook, off-site migration pathways) and coal tar/NAPLs additionally characterized.

Tar Storage Area

Background: The Tar Storage Area comprises almost 1 hectare. Very little is known about site activities during the 88 year operation of coking operations. Information indicates two 15 metre diameter tanks were used to store tar on-site. Apparently these tanks were not associated with the Domtar facility, but how they related to coking operations is not known. The tanks were removed in the late 1980s. Extensive infilling has occurred in this area to achieve present grade. A major rail spur transected the site, and split into three sidings each of which crossed Coke Oven Brook to the Benzol Plant. A major roadway between the Steel Plant, Benzol Plant and Coal Pile Runway crossed the northern part of the site. Site contaminants are likely related to coal tar release around the tanks, spillage of benzol product and/or the fill used on-site. Site work in 1990 focused on the adjacent Domtar facility, rather then this area. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soils and groundwater. Surface soil metals (arsenic, chromium, thallium), and PAHs (benzo(a)pyrene, benzo(a)anthracene) exceeded CCME criteria. Petroleum hydrocarbons (toluene) and other PAHs also exceeded CCME criteria in 1 sample. Evidence of mobile liquid tars were noted on surface. Subsurface soil metals (arsenic), petroleum hydrocarbons (BTX), several PAHs and EPA 625 organics (PAHs, phenol) exceeded CCME criteria. Most contaminants were associated with fills in the former tank area; mobile tars, some discharging into Whitney Pier Brook, were associated with these fills. Groundwater inorganics (turbidity), metals (iron, manganese) and PAHs (benzo(a)pyrene) exceeded CCME criteria in the shallow bedrock, but were considered relatively minor impacts. No petroleum hydrocarbons were detected. Groundwater impacts in shallow bedrock are believed due to overlying contaminated fills, or migration of contaminants from the adjacent Coal Pile Runway. It was recommended that monitoring wells installed continue to be monitored in subsequent work.

Coal Pile Runway

Background: From 1901-1920, the first Coke Oven Battery occupied this entire site. During this period, coke was quenched directly on the ground surface. After 1920, until the late 1980s, the site was used for stockpiling raw coal that was used in Battery Nos. 2 to 6. During full operation, over 150,000 tonnes of coal was usually stored on-site; later the volume was reduced to 20,000 tonnes. Coal sulfur content ranged from 1-1.5 % and development of acid drainage was documented. Periodically sludge from the tar decanter was mixed with coke breeze, deposited in the coal stockpile, and recycled in the Coke Ovens. Post 1950s, mobile equipment was used to move coal, and access roads were sprayed with used oil to suppress dust. In 1985 and 1990, investigative work was completed on-site. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soils and groundwater. Surface soil metals (thallium, arsenic), petroleum hydrocarbon (toluene) and PAH (benzo(a)pyrene) exceeded CCME criteria. Subsurface soil impacts were most frequently associated with metals (arsenic) and PAHs (naphthalene). These impacts were attributed to widespread presence of fill on-site. Groundwater impacts from inorganics (pH, color, turbidity, TDS), and metals (iron, manganese, sulfate) primarily due to acid drainage, were noted in shallow bedrock over the western part of the site. Presence of minor organics, petroleum hydrocarbons (benzene, toluene) and PAHs (benzo(a)pyrene) were also noted above CCME criteria. Site contaminants generally migrate downgradient to the southwest, but some localized migration into the Lower Frederick Street area was also noted. The groundwater contaminant plume from the MAID

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Site within the bedrock, is diverted south of the Coal Pile Runway. Presence of similar impacted bedrock groundwater on-site over the past 12 years suggests either a continued source of contaminants within the fill and/or a very sluggish groundwater flow system within the bedrock beneath the site. It was recommended that surface soils and fills be characterized further, site groundwaters be better assessed (i.e., impact of fill groundwater contamination, presence of coal tars, lateral extent of shallow bedrock contaminant plume, vertical extent of site impacts), geophysical anomalies be further assessed, influence of Coke Oven Brook on site groundwater be assessed, and more groundwater quality data be collected.

Benzol Plant

Background: The Benzol Plant comprises about 3 hectares near the central of the Coke Ovens Site. It began operations in 1944 and was used for recovery of light oil (i.e., 70-75% benzene). Oil was stored in an underground tank farm on-site. After processing, oil was transferred to 2 above ground tanks, located in the Benzol Tank Area. In 1989, the underground tanks were removed; one above ground tank and associated piping remain in-place. Previous site work was conducted in 1985 and 1990. An observed benzol spring near the remaining tank, has historically saturated adjacent fills and during precipitation events discharged to a drain that eventually enters Coke Oven Brook. Previous work has indicated presence of petroleum hydrocarbons and benzol within fills and shallow bedrock groundwaters. Past work also indicated most contaminated groundwater is intercepted by the Cagney Brook Underdrain, which cuts through the western portion of the site and discharges to Coke Oven Brook. 1990 work identified a significant bedrock depression, that is infilled with till and fill. Historic mapping indicates Coke Oven Brook was diverted through the eastern portion of this site. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soils and groundwater. Surface soil metals (arsenic, thallium), petroleum hydrocarbons (toluene, TPH) and PAHs (naphthalene, benzo(a)pyrene) typically exceeded applicable criteria. No PCBs and typically no non-PAH EPA 625 compounds were detected. Carbazole was the only HNC detected. Subsurface soil metals (arsenic, thallium), petroleum hydrocarbons (BTEX, TPH) and PAHs (benzo(a)pyrene) typically exceeded applicable criteria. The highest concentrations were associated with site fills, although some till samples also showed impacts; the greatest impacts were noted within the former Benzol Plant footprint. Benzene and TPH results in these samples, particularly the fill, were among the highest Phase II values. No PCBs and typically no non-PAH EPA 625 organics were detected. Carbazole, an HNC, was detected in most samples. Groundwater was widely affected by elevated levels of petroleum hydrocarbons (benzene, ethylbenzene, TPH), PAHs (benzo(a)pyrene) and metals (iron, manganese) in almost every well. Petroleum hydrocarbon concentrations were much lower then reported for subsurface soils, however, benzene and ethylbenzene were often present at values orders of magnitude above CCME criteria. Substantial naphthalene concentrations were also found in several wells. Phenols and phthalates were generally the only non-PAH EPA 625 organics detected. HNCs, principally carbazole, were detected in several wells. No PCBs were detected. EPA 624 volatile organics (BTEX) were detected in about half of the wells. Contaminant concentrations were generally noted to decrease with depth. Most contaminated groundwater was expected to discharge into Coke Oven Brook. It was recommended that extent of surface soil impacts be refined, relationship between petroleum hydrocarbons contamination and presence of coal be assessed, surface soils contaminant volumes be calculated, vertical extent of groundwater impacts beneath the site be determined, influence of Coke Oven Brook on site groundwater be assessed, and more groundwater quality data be collected.

Benzol Tanks

Background: The Benzol Tanks Site comprises about 2 hectares, in the west-central area of the Coke Ovens Site. Two above ground bulk storage benzol tanks were located on-site; they were decommissioned in 1983 and removed in 1989. The bermed areas and underground piping still exist. In 1983 a large tank (16 metres high) was installed in the northern portion of the site and is still present. Currently, this tank is empty of liquid contents but contains about

5 centimetres of sludge. Reportedly leaks were sometimes noted near these bulk tanks, and quenching operations were halted due to fire hazard. While a significant ongoing source of organic contamination existed during production, most contaminant mass is probably now located in the saturated fill. Potential on-site contaminants probably include residual light oil within fill near the former bulk tanks, and residual NAPL in fill under the existing tank. In 1985 and 1990, very limited site work was conducted. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soil and groundwater. Surface soil metals (arsenic) typically exceeded CCME criteria. Petroleum hydrocarbons and PAHs were often detected but usually not above applicable criteria. No PCBs and typically no non-PAH EPA 625 compounds were detected. Carbazole was the only HNC detected. Dioxins/furans were found below residential CCME criteria (no commercial/industrial criteria). Surface soil within the former bulk tank area was particularly impacted by metals, but petroleum hydrocarbons and PAHs seemed less of an issue. Subsurface soil impacts occur throughout the site, however the former bulk tank area was most effected. Most metal impacts occurred in fill materials, although undisturbed till also contained some elevated metals. Petroleum hydrocarbons (BTX, TPH) above applicable criteria occurred primarily in fill materials associated with the former benzol tanks. Where detected, PAHs were generally below CCME; however, within the central site area elevated values were detected and likely associated with buried creosote timbers. No PCBs, HNCs and typically no non-PAH EPA 625 compounds were detected. Groundwater inorganic (color, turbidity), metals (iron, manganese), PAHs (benzo(a)pyrene) typically exceeded CCME criteria. Fill and shallow bedrock groundwater quality in the northern area was most impacted and the shallow bedrock groundwater is highly contaminated by benzene. Fill groundwater at this site is contaminated by many PAHs (e.g., phenanthrene, naphthalene) and to a lesser degree by benzene. Impacted groundwater from the Benzol Tanks is expected to discharge into Coke Oven Brook. It was recommended that extent of benzene in groundwater be delineated, potential for NAPLs be assessed in selected site areas, influence of Coke Oven Brook on site groundwater be assessed, and more groundwater quality data be collected.

Coke Storage Area

Background: The Coke Ovens Coke Storage and Oven No.2 Site is about 5 hectares and located near the center of the Coke Ovens Site. During operation of the Coke Ovens, coke produced in the batteries was temporarily stored on a 1.6 hectare pad in this area, between approximately 1966 and 1988. Prior to 1939, facilities considered to be Oven No. 2 were located in the northern portion of this site. A coal wash facility and conveyor lines to Battery Nos. 2 to 6 were previously located in the northwest corner of the site. Remaining infrastructure consists of footings for Oven No. 2, a water tank and water line. Little intrusive work was previously undertaken in this area. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soils and groundwater. Surface soil metals (arsenic, thallium), petroleum hydrocarbons (toluene, TPH) and PAHs, (benzo(a)pyrene) frequently exceeded CCME criteria. Surface soil impacts occur widely, but are most prevalent in the southwestern site area. No PCBs and typically no non-PAH EPA 625 compounds were detected. Carbazole was the only HNC detected. Subsurface soil impacts were mostly attributable to fill materials, although undisturbed the till also had petroleum hydrocarbons (TPH) impacts in the northern site area. Groundwater PAHs (benzo(a)pyrene, naphthalene) were the dominant contaminants identified in shallow bedrock groundwater, and the highest concentrations were detected in the cental and southwestern areas of the site. Petroleum hydrocarbons were not identified as a primary contaminant in groundwater at this site. Groundwater flow directions at the site are predominantly to the northwest. Much of the groundwater contamination originating from subsurface soils is expected to discharge to Coke Oven Brook. It was recommended that the vertical extent of groundwater impacts be determined beneath the site, influence of Coke Oven Brook on site groundwater be assessed, more groundwater quality data be collected, and soil contaminant volumes be calculated, based upon extent of product in selected areas and the contaminant extent be refined.

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Sulphur Building

Background: The Sulphur Building Site comprises an area of about 1 hectare and is centrally located within the Coke Ovens Site. At this site, sulphur was used to produce sulfuric acid for the extraction of ammonia sulphate from the Coke Oven's gas. A 1985 study found coal tar underlying fill at one location and PAH contamination was detected in the shallow bedrock. Information indicates that the eastern portion of this area contained fill with residual tar and that other Coke Ovens Site areas may also be similarly contaminated. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soils and groundwater. Surface soil data indicated few impacts, based on a single sample. Subsurface soil metals (arsenic) and PAHs (benzo(a)pyrene, phenanthrene) typically exceeded CCME criteria. Most subsurface contamination appears to be located within fill materials in the eastern site area. Some of these contaminants have dissolved in the overburden aquifer and migrated into the underlying shallow bedrock aquifer. Groundwater inorganics (color, turbidity, TDS) and metals (sulfate, iron, manganese) frequently exceeded CCME criteria. Generally the northern end of the site shows fewer groundwater impacts, which consist largely of elevated general inorganics and metals. Contaminated site groundwater is expected to move towards and discharge into Coke Oven Brook. It was recommended that the vertical extent of groundwater contamination be determined beneath the site, influence of Coke Oven Brook on site groundwaters be assessed, more groundwater quality data be collected, extent of infrastructure be assessed, and soil contaminant volumes be developed.

Coke Battery Nos. 2 to 6

Background: Coke Battery Nos. 2 to 6 comprise about 4 hectares in the south-central Coke Ovens Site. Between 1911-1927, Battery No. 1 was replaced with Battery Nos. 2, 3 and 4; these batteries were ultimately replaced with Battery Nos. 5 and 6 in 1949 and 1953, respectively. All batteries were located in an east-west line, north of the By-Products Building. Battery No. 6 was largely constructed over Battery No. 4, while Battery No. 5 extended over the Cagney Brook underdrain. Battery Nos. 5 and 6 contained in total 114 vertical slot ovens with an estimated capacity of 600,000 tons of coke per year. Raw coal was fed into oven compartments through charging holes on top of the batteries, and was heated to 1200° C with little oxygen for an 18 to 24 hour period. "Cooked" coke was pushed into a car and transferred to the Quenching Tower where it was water cooled. Once cooled, the coke was returned to the batteries and fed by conveyor to the crushing and screening plant northeast of the batteries; here the coke was sorted for various uses. The coarsest component (furnace coke) was taken directly to the blast furnaces. The fines or breeze, were either used in the sinter plant/boilers, or discarded if it could not be used. Gases drawn off during cooking went to a primary cooling tank in the By-Products Building. The Quenching Tower was located northwest of the batteries near the Benzol Tanks. The quenched coke load-out area was located north of Battery No. 5. The batteries were demolished in the late 1980s, but remnants of brick and steel remain and it is assumed the oven basements are flooded. Limited intrusive work was conducted in this area in 1985 and 1990. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soil and groundwater. Surface soils were primarily impacted with metals, while petroleum hydrocarbon and PAH impacts were detected to a lesser degree. Subsurface soil impacts included metals, petroleum hydrocarbons and PAHs. In a northern subsurface soil sample, hydrocarbons (BTEX) and elevated PAHs (naphthalene), were identified. Presence of soil contaminants was attributed to long term site storage/handling of coal and coke products and/or impacts from adjacent sites. Groundwater results in this northern area also showed the greatest impact. Groundwater contaminants were highest in a shallow bedrock well impacted by PAHs (naphthalene), and to a lesser degree by petroleum hydrocarbons. A paired till well, was impacted by similar contaminants but at much lower concentrations. Soil and groundwater impacts do not appear directly related to particular sources, however the area of greatest impact was noted to be in the northeastern portion of the site. It was recommended that the extent of soil and groundwater impacts within selected portions of the site be defined, the

vertical extent of groundwater contamination be determined, further assessment of site infrastructure be undertaken to determine if it is a source or pathway for contaminants, and more groundwater quality data be collected.

By-Products Building

Background: The By-Products Building Site comprises about 4 hectares in the southern Coke Ovens Site area. This building contained an exhauster, primary coolers and an ammonia stripper; the building shell still remains. Large quantities of hazardous materials were transferred, used and stored at this building over a 70 year period. An ammonia building was located on the west side of the By-Products Building, and three coal tar storage tanks and a tar decanter building were located north of the ammonia building. Gases drawn off the coke batteries were sent to a primary cooling tank where coal tar was precipitated and water vapor condensed from the gas. The water was then saturated with ammonia and used as a flushing liquor to capture coal tar and other particulate material in the collector mains. The liquor was then decanted to remove the coal tar. The tar was stored in tanks and eventually transferred to the Domtar Site, while the liquor was re-circulated. The site also contained an above grade structure for storage of gas and scrubbers for extracting naphthalene. Other buildings or structures included exhaust stacks in the west portion of the site, coolers and scrubbers located in an easterly area, service shops to the south and transfer stations to the southwest. The site surface area was significantly disturbed by construction of buildings, support structures, the Cagney Brook underdrain, site operations, and demolition activities. Previous intrusive work was completed in 1985 and 1990 at this site. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results confirm impacts to both soil and groundwater. Surface soil metals (thallium) and PAHs (benzo(a)pyrene, naphthalene) generally exceeded CCME criteria. Petroleum hydrocarbons (TPH) impacts were detected northeast of the building. Subsurface soil metals (arsenic) and petroleum hydrocarbons (BTX, TPH) typically exceeded CCME criteria. To a lesser degree PAHs (benzo(a)pyrene) impacts were also noted. Some soil impacts may be associated with coal material in the fill/till matrix. Most subsurface soil impacts were associated with fill samples or till materials underlying fills. Groundwater impacts were most significant in the shallow bedrock, particularly the eastern site area, fewer impacts were noted in fill/till and deeper wells. Shallow bedrock groundwater was most impacted by inorganics (chloride, sulfate) and PAHs (benzo(a)pyrene, naphthalene); petroleum hydrocarbon (BTEX, TPH) impacts appeared to be more localized. Presence of contaminants was attributed to past site activities, possible airborne fallout from the Coke Ovens Site, on-site contaminanted fills and/or upgradient sources (e.g., Mullins Bank). Site infrastructure (e.g., Cagney Brook underdrain), probably provide pathways for contaminant migration from the surface downwards, as well as between areas within the Coke Ovens Site. It was recommended that additional surface soil and groundwater testing be undertaken to further delineate site impacts and support remediation work, and more groundwater quality data be collected.

Mullins Coal Bank

Background: Mullins Coal Bank comprises about 12 hectares and forms much of the southern boundary of the Coke Ovens Site. It was used from the early 1930s until the late 1980s for the temporary storage of coal prior to shipment overseas. The site contained a rail accessible transfer bank and coal pads. Cagney Brook was diverted through the site via an underground tunnel system that extended from the former tramway north of Vulcan Avenue, to Coke Ovens Brook. As part of the 1990s demolition activities, a drainage ditch was constructed on-site to control surface waters and lower the groundwater levels; it extended from the southside of Mullins Coal Bank to Coke Oven Brook. Decommissioning also included removal of coal stock piles, and grading and seeding of the area. Limited intrusive work was completed within this area in 1990. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results indicate limited impacts to both soils and groundwater. Surface and subsurface soil impacts were limited to metals (arsenic). Almost all PAHs and all petroleum hydrocarbons met CCME criteria. Groundwater impacts were mostly associated with general chemistry (TDS, sulfate) and metals (iron, manganese). Comparatively low concentrations of PAHs (benzo(a)pyrene) were noted in most site wells. No petroleum

hydrocarbons were detected in groundwater. Soil and groundwater impacts were found in samples collected near the Cagney Brook underdrain. Groundwater quality near the Cagney Brook underdrain exhibited low pH and high TDS, relative to other site groundwater samples. Soil contaminants were attributed to long term storage/handling of coal products and/or impacts from the adjacent By-Products Building. Groundwater impacts likely reflect water infiltration through these coal and/or fill materials containing coal fines. Cagney Brook underdrain was considered to provide a pathway for contaminant migration. It was recommended that, work be undertaken in select areas to define extent of soil/groundwater impacts, and more groundwater quality data be collected.

Non-Point Source Areas

Five Non-Point Source Areas on the Coke Ovens Site total about 24 hectares, and includes the MAID Plume Area which borders the MAID Site, the Eastern Area, the Southeast Area, Administration Area and Domtar Area.

MAID Plume Area

Background: The MAID Plume Area was so named because it was believed to be underlain by a major contaminant plume that migrates eastward from the upgradient MAID Site. No surface features (i.e., buildings, foundations) presently exist in this area. However, a series of railway lines through portions of the site and two coal fine settling ponds associated with a CBDC coal washing facility, were apparently located within the central portion of this site. The coal washing facility was seemingly located just beyond the western boundary of the MAID Plume Area. Both coal fine settling ponds were apparently infilled with granular material by 1985. Apparently no previous intrusive work has been completed within this area. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results indicate soil and groundwater impacts. Surface soil metal (arsenic) impacts were noted in samples collected throughout the site and were probably related to presence of coal material within the fill, which constituted most surface soils. Relatively minor petroleum hydrocarbon (toluene) impacts were noted in one sample, and might also be related to presence of coal material. No PAH impacts were noted. Subsurface soil impacts were similar to surface soils (i.e., arsenic and toluene). Evidence of localized subsurface soil contamination was noted based upon the data collected. No PAH or other EPA 625 organic impacts were noted. Groundwater contamination within the shallow bedrock was identified in both the eastern and western portions of the site. This contamination was associated with elevated concentrations of inorganic (TDS, sulfate, ammonia) and metal (iron, manganese) parameters. Elevated gross alpha and beta values were also detected; the cause for these elevated values is not known. Relatively minor PAH (benzo(a)pyrene) exceedences of CCME criteria were noted in several wells. No petroleum hydrocarbons, PCBs, HNCs, EPA624 volatile organics and typically no non-PAH EPA625 compounds were detected. Eastern groundwater impacts were considered due to westward migration of MAID Site leachate impacted groundwaters and westward migration was supported by Phase II geophysical data. It was not clear whether groundwater impacts in this western site area were also associated with impacts from the MAID Site. Shallow bedrock groundwater flow directions and the lack of low pH values within the eastern site area, suggest other factors may be at least partially responsible for the western groundwater impacts. The presence of coal bearing fills and/or remaining buried coal material from previous site operations, were considered to be the most likely sources for these western groundwater impacts. It was recommended that characterization of coal bearing site soils be undertaken, relationship of fill materials to groundwater impacts and geophysical anomalies be assessed, lateral/vertical extent of the MAID Site contaminant plume be assessed, identified geophysical anomalies be further assessed and more groundwater quality data be collected.

Summary of the Muggah Creek Phase II Environmental Site Assessment

Eastern Area

Background: The Eastern Area was so named because it lies along the eastern boundary of the Coke Ovens Site operational area. No aboveground facilities currently exist within the Eastern Area. This site was associated with coal transfer and storage areas, and related facilities. Railcars loaded with coal would loop through the northern portion of the site, discharge coal via bottom dumping at a bridge crossing, then complete the loop and begin the return easterly trip. Coal dumped at this bridge was moved to the Mullins Coal Bank. A CBDC coal washing and screening facility, and associated settling ponds were apparently part of this operation. This coal washing facility was located within the Eastern Area while the two settling ponds for coal fines, were apparently located within the adjacent MAID Plume Area. There is no evidence that previous subsurface intrusive work has been completed within the Eastern Area. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results indicate soil and groundwater impacts. Surface soil metal (arsenic) values above CCME criteria were observed in fill surface soils throughout the site and were probably related to presence of coal material within the fill. No PAHs exceeded CCME criteria. Subsurface soil metal (arsenic) values above CCME criteria were also noted. However, few impacts were identified and no evidence of widespread contamination was noted; most impacts were associated with fill materials. During test pitting, organic odors were noted in two locations but the source was not established. Groundwater inorganics (color, turbidity), metals (iron, manganese) and gross alpha/beta typically exceeded CCME criteria. Shallow bedrock groundwater impacts were noted within both the northern and central portions of the site. The cause for elevated gross alpha/beta values was not known. Some PAHs were detected in one well but were not considered significant. No petroleum hydrocarbons, PCBs, HNCs, EPA 624 or 625 organics were detected. Impacts in the northern area were believed to be associated with leachate impacted surface water from Coke Oven Brook. Sources for impacts in the central area were not known, but could be due to westward migration of contaminated groundwater from the MAID Plume Area, or a localized source. Groundwater within the southern site area was not impacted and considered representative of background groundwater quality. It was recommended that characterization of fill materials be undertaken to assess both relationships with the low pH groundwater and product extent noted in one localized area, more monitoring wells be installed to assess possible MAID Site contaminant plume and Coke Oven Brook impacts, and identified geophysical anomalies be further assessed.

Southeast Area

Background: This Non-Point Source Area is identified on Figure 1. Although existing information did not reveal potential sources of contamination related to specific site activities, it was recognized that impacts could be present due to its proximity to adjacent sites that were impacted (e.g., By-Products Building). Limited intrusive work was completed within this area in 1990. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results did not indicate any soil impacts and presence/absence of groundwater impacts could not be confirmed. Surface soil data was not available for this area. Subsurface soils did not detect petroleum hydrocarbons, PAHs or PCBs in the samples collected. No metal impacts were noted. Groundwater data was not collected due to low water table conditions within the only on-site well, hence presence/absence of impact to groundwaters could not be confirmed. It was recommended that additional surface soil sampling be undertaken and groundwater quality data collected.

Summary of the Muggah Creek Phase II Environmental Site Assessment

Administration Area

Background: The Administration Area contains the former administration area for the Coke Ovens Site and was also the main access point to the Coke Ovens facility during operation. It currently contains the on-site security trailer, as well as water and sewer piping that is connected to the municipal system. No previous intrusive work has been undertaken in the area. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results indicate soil and groundwater impacts. Surface soil results indicate metals (arsenic, chromium, vanadium) exceeded CCME criteria in the central site area. These results are similar to those found at adjacent sites. Subsurface soils were impacted by metals (arsenic) and various PAHs and these impacts occur throughout the site. Petroleum hydrocarbons did not exceed applicable criteria. Subsurface soil metals (arsenic) and PAHs (benzo(a)pyrene) typically exceeded CCME criteria. Impacts were mostly detected in shallow fill materials, and the northern and central site areas had the highest PAHs concentrations. Petroleum hydrocarbons did not exceed applicable criteria. Groundwater in the shallow bedrock was impacted by inorganics (TDS, turbidity), metals (iron, manganese) and gross alpha/beta that typically exceeded CCME criteria. Cause for elevated gross alpha and beta values is not known. Elevated PAHs (benzo(a)pyrene) were found in shallow bedrock groundwater and are probably associated with elevated fill PAHs found at this location. No other organics (petroleum hydrocarbons, HNCs. PCBs) were either detected or exceeded CCME criteria. Contaminated groundwater from this site is expected to discharge into Coke Oven Brook. It was recommended that relationships between PAH contamination and presence of coal be assessed, contaminant extents be refined, soil contaminant volumes be estimated, influence of Coke Oven Brook on site groundwater be assessed, vertical extent of groundwater contamination be determined beneath the site, and more groundwater quality data be collected.

Domtar Area

Background: The Domtar Area comprises about 2 hectares. Very little is known about activities within the Domtar Area during the 88 years of coking operations. Existing information suggests this area was not heavily utilized by coking and/or ancillary operations. Apparently this area was infilled to achieve its present grade, especially near Coke Oven Brook. The northern portion of the site was transected by a major rail spur to the Benzol Plant and an access road between the Steel Plant, Benzol Plant and Coal Pile Runway. Although this area was considered to represent a relatively minor, non-point contaminant source area, point source contamination related to release of benzol product in tank cars along the rail spurs, and fill materials was possible. Limited intrusive work was completed within the southern portion of the area in 1990, while in 1999 geophysical work was undertaken within this site. Phase II ESA work is summarized in Tables 1 and 2.

Results: Phase II results indicated minor localized soil and groundwater impacts. Surface soil impacts from metals (thallium, arsenic) were noted, and was consistent with results for adjacent sites (Domtar Plant, Tar Storage Area). Subsurface soils had similar, albeit higher, metal impacts and the highest concentrations were associated with fills. No petroleum hydrocarbons or PCBs were detected. PAHs were detected in several samples and seven PAHs exceeded CCME criteria in one fill sample. Groundwater exceedences for inorganic parameters (color, turbidity), metals (iron, manganese) and gross alpha/beta were noted in fill and/or bedrock groundwaters, but were not considered significant. Gross alpha, beta and gamma values above CCME criteria were typically within the range of background values for these parameters. Upgradient groundwater impacts (inorganics and metals) from the Coal Pile Runway did not extend into this site. PAH (benzo(a)pyrene, naphthalene) impacts were noted in shallow bedrock groundwater within the southwest corner of the site. Comparison with 1988 data indicates increases in TDS, pH and naphthalene values with time. It is not known if these PAH impacts result from downward transport from the fill, or some association with NAPLs at depth. It was recommended that impacted well PN88-5 be monitored in any subsequent work.

Summary of the Muggah Creek Phase II Environmental Site Assessment

SURFACE WATERWAYS

Background: The Muggah Creek drainage area includes Coke Oven and Wash Brooks sub-watersheds that form about 90% of the area contributing to surface runoff to North and South Ponds. The Surface Waterways Monitoring Program was developed based on a detailed Phase II ESA sampling event. Work included sampling of flow and water chemistry, stream bed sediment and cores of stream bed materials in the Fall of 2000. The 10 primary and 11 secondary stations required for this first sampling event were field inspected and prepared for monitoring during August 2000. Stations were located on Background, Cagney, Coke Oven, Domtar, Frederick Street, Incinerator, Radar, Wash and Whitney Pier Brooks. Background Brook forms the initial portion of Coke Oven Brook north of the MAID Site. The September 2000 sampling event, near the end of the Summer Quarter, exhibited dry, but normal weather conditions. Work included monitoring of surface water flow; collection of surface water samples; and measurement of groundwater levels in adjacent wells over a 7 hour period. Four ground/surface water interaction sites were established to help evaluate contaminant transport between groundwater and surface water. Near surface stream sediment samples were also collected in September, and four sites were cored in October to determine presence of deeper impacts. Stream flows were compared to Environment Canada's McAskill Brook watershed. Limited previously work had been undertaken on sections of a few streams (e.g., Coke Oven, Background Brooks) but no comprehensive surface water program had been undertaken. The surface waterways work is summarized in Tables 1 and 2.

Results: Phase II results indicate surface water and sediment impacts. Several surface water stations (i.e., Radar, Whitney Pier, Frederick Street and Cagney Brooks; the Conveyor Tunnel and Benzol Plant Drain) were dry and couldn't be sampled. A general increase in discharge down Coke Oven Brook indicated increased contribution from groundwater, and was supported by groundwater data. Under these low flow conditions, travel time for contaminants to reach South Pond from the MAID Site is about 6-7 hours. Surface water inorganics (nitrate, ammonia) and metals (iron, copper, nickel, selenium) often exceeded CCME criteria. Stations along Coke Oven Brook most frequently exceeded CCME criteria. Petroleum hydrocarbons (toluene) only exceeded CCME criteria at two stations on Coke Oven Brook. Various PAHs exceeded CCME criteria; the highest concentrations were found at the mouth of Coke Oven Brook and within Domtar Brook. No PCBs were detected. Sediment contaminants temporarily stored on stream bed sediments were noted. Loose bed sediment is very mobile and easily moved downstream by storm flows. Concentration of total metals at the mouths of Coke Oven and Wash Brooks were generally similar (i.e., about 22,000 mg/kg). Arsenic, copper, lead and mercury often exceeded CCME criteria, and to a lesser degree cadmium, chromium and zinc. A zone of high metals was found below the MAID Site within Coke Oven Brook. Petroleum hydrocarbons at the mouth of Coke Oven Brook were elevated relative to the mouth of Wash Brook, where none were detected; no CCME criteria exist for hydrocarbons in freshwater sediments. Total PAH concentrations at the mouth of Coke Oven Brook were 123 times greater than that at the mouth of Wash Brook. Numerous PAHs exceeded CCME criteria at most stations, especially on Coke Oven Brook. LNAPLs were present in Domtar Brook and associated with underlying DNAPLs. DNAPLs were also present below the bed of Coke Oven Brook downstream of former Coke Ovens Site discharge points. It was recommended that 10 surface water monitoring stations be carried into the Surface Waterways Monitoring Program, groundwater-stream interaction sites and adjacent wells also be included, and any program refinements be made after completing the Spring 2001 sampling event.

Summary of the Muggah Creek Phase II Environmental Site Assessment

Table 1 - Summary of Phase II Investigation Points				
Site	**Surface Soil Samples**	**Test Pits**	**Boreholes**	**Monitoring Wells**
NOCO	27	16	5	23
- Upper Frederick Street	5	-	-	5
- Middle Frederick Street	12	4	3	8
- Lower Frederick Street	4	12	2	4
- West of Lirgan Road	6	-	-	6
MAID	99	29	4	31
- North Perimeter	2	-	-	3
- West Perimeter	-	6	-	6
- Sydney Landfill	4	23	4	15
- Central Area	3	-	-	7
Coke Oven Bk Connector	3	4	-	10
Coke Ovens Site	47	132	-	92
- Domtar	6	20	-	10
- Tar Storage	4	7	-	2
- Coal Pile Runway	2	16	-	7
- Benzol Plant	3	15	-	17
- Benzol Tanks	5	9	-	6
- Coke Storage	5	9	-	4
- Sulphur Building	2	4	-	3
- Coke Batteries	5	10	-	5
- By-Products Building	2	8	-	8
- Mullins Coal Bank	2	11	-	7
Non-Point Source Area				
- MAID Plume Area	3	9	-	9
- Eastern Area	4	6	-	3
- Southeast Area	1	2	-	1
- Administration Area	1	2	-	4
- Southeast Area	2	4	-	6
Note: The above numbers represent new investigative points that were added as part of the Phase II ESA				

Summary of the Muggah Creek Phase II Environmental Site Assessment

Table 2 - Summary of Phase II Analytical Program

Analytical Parameter / Site	BTEX/DTPH	PAH	Metals	Cyanide	Mercury	EPA 624	EPA 625	PCBs	Dioxin/Furans	HNCs	RCAp-MS (plus	Radiologicals
NOCO	66	66	66	60	47	6	15	13	7	16	29	1
- Upper Frederick Street	12	11	17	11	8	2	3	3	-	3	9	1
- Middle Frederick Street	21	17	22	15	12	1	5	4	3	5	8	-
- Lower Frederick Street	20	23	30	23	16	1	5	5	2	5	4	-
- West of Lingan Road	13	15	19	11	11	2	2	1	2	3	8	-
MAID	75	53	81	57	55	33	30	25	-	33	43	41
- North Perimeter	7	4	7	5	5	2	3	4	-	3	3	3
- West Perimeter	12	10	17	13	12	8	6	1	-	6	12	12
- Sydney Landfill	33	19	31	16	15	13	14	14	-	17	14	14
- Central Area	23	20	26	23	23	10	7	6	-	7	14	12
Coke Oven Blk Connector	13	22	30	22	9	2	3	3	-	3	8	-
Coke Ovens Areas	189	220	337	258	135	30	73	61	3	86	96	9
- Dorntar	34	23	52	42	23	9	25	15	2	26	14	-
- Tar Storage	4	7	11	7	3	-	1	-	-	1	1	-
- Coal Pile Runway	11	19	25	22	13	1	4	3	-	6	9	-
- Benzol Plant	41	36	51	46	29	7	15	12	-	18	20	-
- Benzol Tanks	14	12	26	11	6	-	3	3	1	3	6	-
- Coke Storage	11	14	21	10	5	2	3	5	-	4	4	-
- Sulphur Building	6	10	10	7	4	-	-	-	-	-	3	-
- Coke Batteries	14	11	22	10	9	2	6	7	-	7	5	-
- By-Products Building	17	12	22	22	13	4	9	7	-	11	8	-
- Mullins Coal Bank	14	23	25	23	8	1	1	1	-	1	8	-
Non-Point Source												
- MAID Plume Area	13	28	32	29	11	2	3	4	-	6	9	4
- Eastern Area	4	8	14	8	3	1	2	1	-	1	3	3
- Southeast Area	1	3	2	2	-	-	-	1	-	-	-	-
- Administration Area	3	5	9	7	-	1	1	1	-	1	2	2
-Dorntar	2	9	15	12	8	-	-	1	-	1	6	-
Surface Waterways	51	15	70	65	69	-	22	21	6	23	41	-

Notes:
1 - QA/QC samples are not included in the above numbers.

Summary of the Muggah Creek Phase II Environmental Site Assessment

Table 3 - Abbreviations and Units used in this Presentation Summary Report

Abbreviations

BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BTE	Benzene, Toluene, Ethylbenzene
BTX	Benzene, Toluene, Xylene
CBDC	Cape Breton Development Corporation
CBEG	Cape Breton Environmental Group
CBRM	Cape Breton Regional Municipality
CCME	Canadian Council of Ministers of the Environment
COB	Coke Oven Brook
COBB	Coke Ovens By-Products Building
COBP	Coke Ovens Benzol Plant
COBT	Coke Ovens Benzol Tanks
COCO	Coke Ovens Coke Oven (Brook)
COCP	Coke Ovens Coal Pile Runway
COCS	Coke Ovens Coke Storage
CODT	Coke Ovens Domtar Site
COWP	Coke Ovens Whitney Pier (Brook)
DNAPL	Dense non-aqueous phase liquid (e.g., coal tar)
DTB	Domtar Brook
EPA	Environmental Protection Agency (United States)
EPA 624	A specific set of volatile organic parameters
EPA 625	A specific set of semi-volatile organic parameters
ESA	Environmental Site Assessment
FWAL	Freshwater Aquatic Life Guidelines (CCME)
HNC	Heterocyclic nitrogenous compounds
JAG	Joint Action Group
LNAPL	Light non-aqueous phase liquid (e.g., benzol)
MAID	Municipal Ash and Industrial Disposal Site
MW	Monitoring well (may be MWA, MWB, MWC)
NAPL	Non-aqueous phase liquid (e.g., oil)
NOCO	Area North of Coke Ovens
PAH	Polycyclic aromatic hydrocarbons
PIRI	Partners in RBCA Implementation
PCB	Polychlorinated biphenyl
QA/QC	Quality assurance/quality control
RBCA	Risk Based Corrective Action
SD	Sediment sample
SLR	Stage level recorder (stream station for measuring water levels)
SOP	Standard operating procedure
TCU	True color units
TDS	Total dissolved solids
TP	Test pit
TPH	Total petroleum hydrocarbon

Units

cm	centimetres
m	metres
mg/kg	milligrams per kilogram (i.e., equivalent to ppm)

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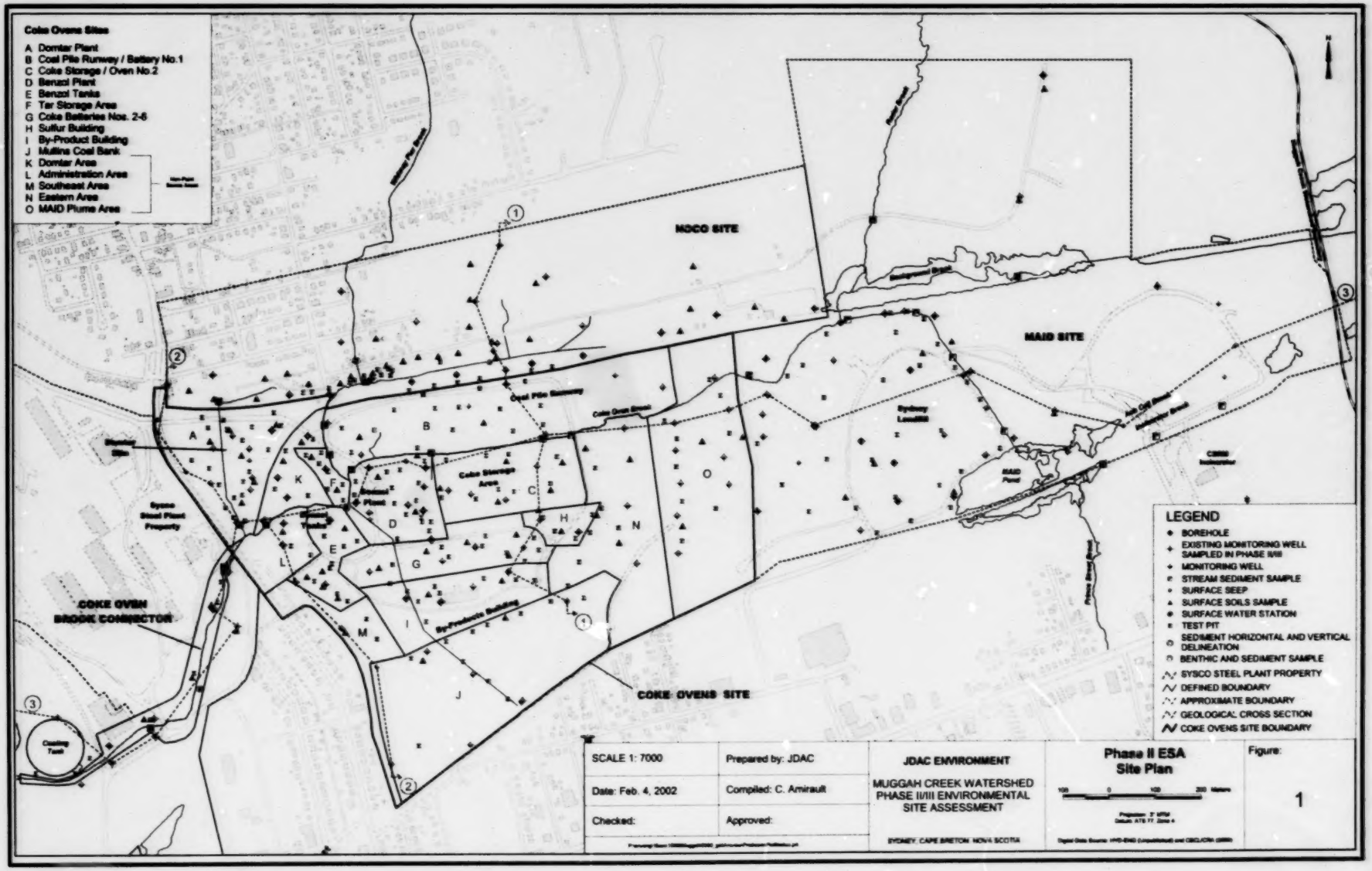
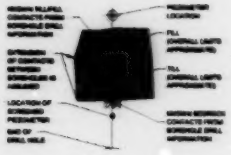
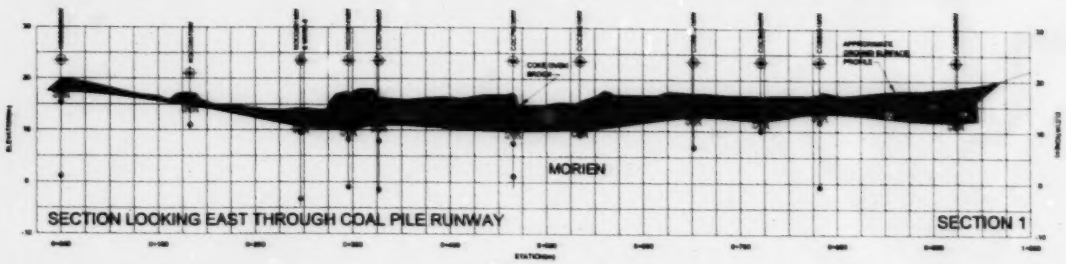
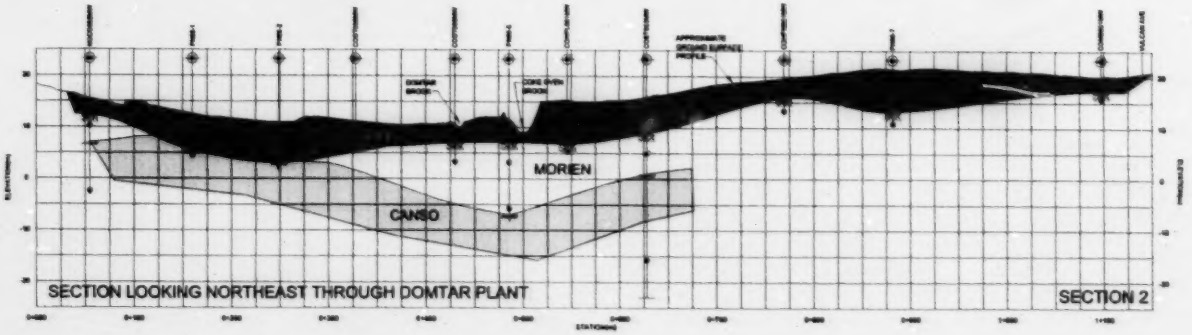

Coke Ovens Sites
A Domtar Plant
B Coal Pile Runway / Battery No.1
C Coke Storage / Oven No.2
D Benzol Plant
E Benzol Tanks
F Tar Storage Area
G Coke Batteries Nos. 2-6
H Sulfur Building
I By-Product Building
J Mullins Coal Bank
K Domtar Area
L Administration Area
M Southeast Area
N Eastern Area
O MAID Plume Area
Non-Plant Source Areas
MOCO SITE
MAID SITE
COKE OVEN BROOK CONNECTOR
COKE OVENS SITE
Coal Pile Runway
Coke Oven Brook
Coke Storage Area
By-Product Building
Sysco Steel Plant Property
Coking Tars
Ash
Sydney Tar Ponds
Muggah Creek
Sydney Coal Field
MAID Pond
Prince Street Road
CBRM Incinerator
LEGEND
BOREHOLE
EXISTING MONITORING WELL SAMPLED IN PHASE II/III
MONITORING WELL
STREAM SEDIMENT SAMPLE
SURFACE SEEP
SURFACE SOILS SAMPLE
SURFACE WATER STATION
TEST PIT
SEDIMENT HORIZONTAL AND VERTICAL DELINEATION
BENTHIC AND SEDIMENT SAMPLE
SYSCO STEEL PLANT PROPERTY
DEFINED BOUNDARY
APPROXIMATE BOUNDARY
GEOLOGICAL CROSS SECTION
COKE OVENS SITE BOUNDARY
N
SCALE 1: 7000
Prepared by: JDAC
Date: Feb. 4, 2002
Compiled: C. Amirault
Checked:
Approved:
JDAC ENVIRONMENT
MUGGAH CREEK WATERSHED
PHASE II/III ENVIRONMENTAL
SITE ASSESSMENT
SYDNEY, CAPE BRETON, NOVA SCOTIA
Phase II ESA
Site Plan
100 0 100 200 Metres
Figure:
1

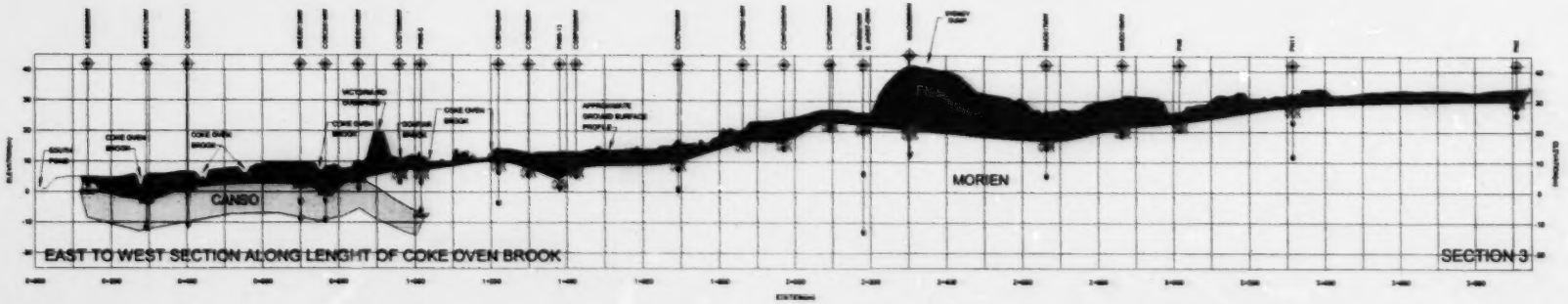
LEGEND:





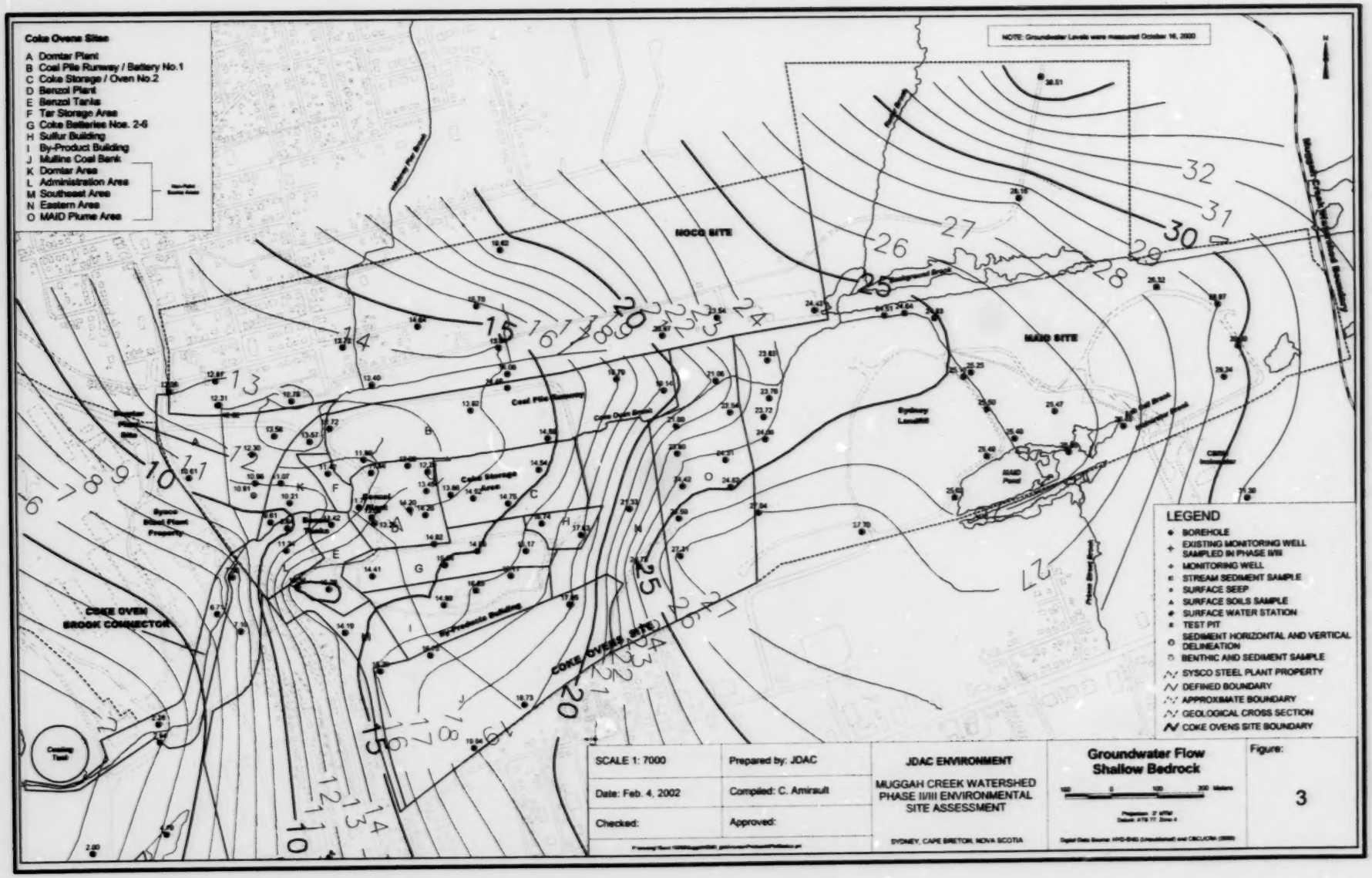
SECTIONS 1 & 2





SECTION 3

SCALE: N/A	Prepared by: JDAC	JDAC ENVIRONMENT MUGGAH CREEK WATERSHED PHASE II/III ENVIRONMENTAL SITE ASSESSMENT SYDNEY, CAPE BRETON, NOVA SCOTIA	**Phase II Geologic Cross Sections**	Figure: 2
Date: Feb. 4, 2002	Compiled: C. Amiault			
Checked:	Approved:			


Coke Ovens Sites
A Dominion Plant
B Coal Pile Runway / Battery No.1
C Coke Storage / Oven No.2
D Benzol Plant
E Benzol Tanks
F Tar Storage Area
G Coke Batteries Nos. 2-6
H Sulfur Building
I By-Product Building
J Mullins Coal Bank
K Dominion Area
L Administration Area
M Southeast Area
N Eastern Area
O MAID Plume Area
NOTE: Groundwater Levels were measured October 16, 2000
N
NOCO SITE
MAID SITE
COKE OVEN BROOK CONNECTOR
COKE OVENS SITE
Coke Oven Brook
Coal Pile Runway
Coke Storage Area
By-Products Building
Sydney Lanalim
Sydney Steel Plant Property
Dosing Tank
LEGEND
BOREHOLE
EXISTING MONITORING WELL SAMPLED IN PHASE II/III
MONITORING WELL
STREAM SEDIMENT SAMPLE
SURFACE SEEP
SURFACE SOILS SAMPLE
SURFACE WATER STATION
TEST PIT
SEDIMENT HORIZONTAL AND VERTICAL DELINEATION
BENTHIC AND SEDIMENT SAMPLE
SYSCO STEEL PLANT PROPERTY
DEFINED BOUNDARY
APPROXIMATE BOUNDARY
GEOLOGICAL CROSS SECTION
COKE OVENS SITE BOUNDARY
SCALE 1: 7000
Prepared by: JDAC
Date: Feb. 4, 2002
Compiled: C. Amirault
Checked:
Approved:
JDAC ENVIRONMENT
MUGGAH CREEK WATERSHED PHASE II/III ENVIRONMENTAL SITE ASSESSMENT
SYDNEY, CAPE BRETON, NOVA SCOTIA
Groundwater Flow Shallow Bedrock
Figure:
3